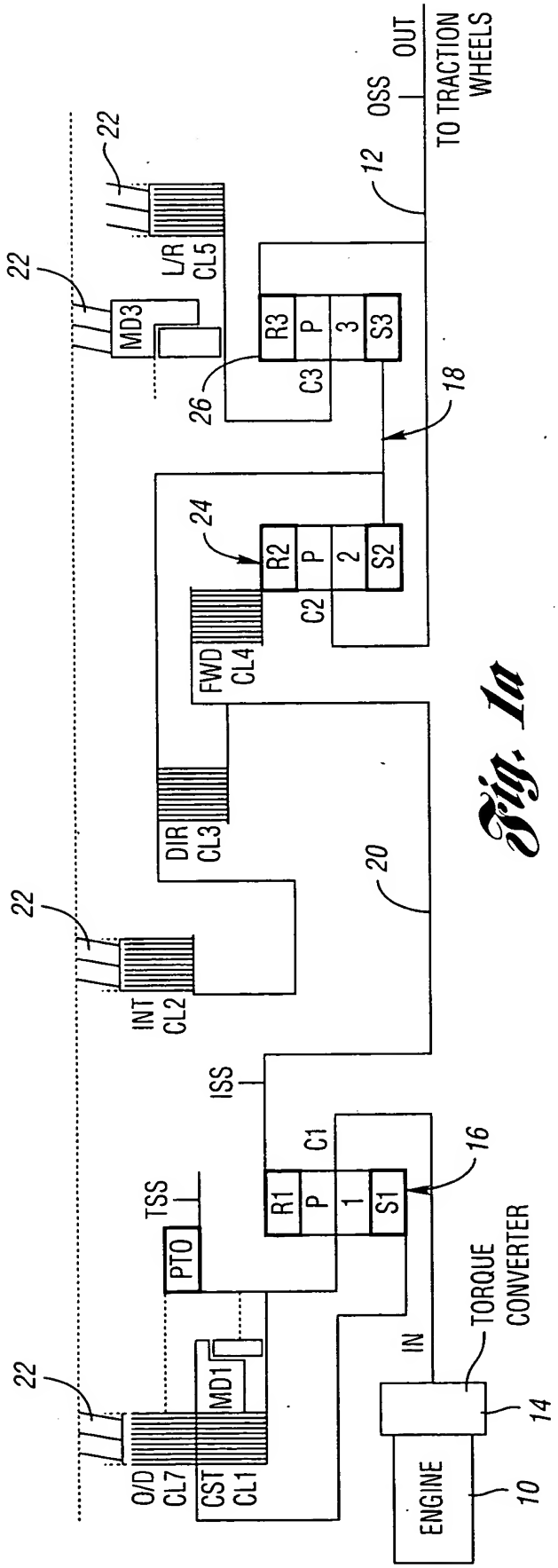
ENGINE
10
14
TORQUE CONVERTER
IN
16
R1
P
1
S1
C1
ISS
20
R2
P
2
S2
C2
24
R3
P
3
S3
C3
26
18
OSS
OUT
TO TRACTION WHEELS
12
22
O/D CL7
CST CL1
MD1
PTO
TSS
INT CL2
DIR CL3
FWD CL4
MD3
L/R CL5

Fig. 1a

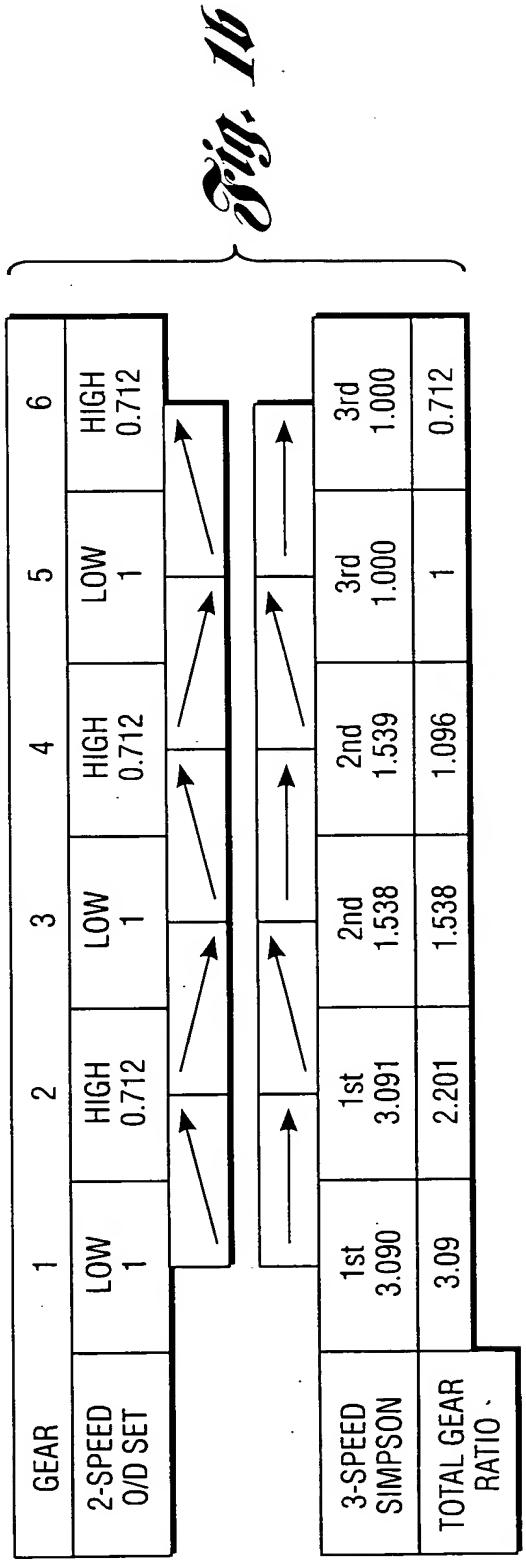
GEAR
1
2
3
4
5
6
2-SPEED O/D SET
LOW 1
HIGH 0.712
LOW 1
HIGH 0.712
LOW 1
HIGH 0.712
3-SPEED SIMPSON
1st 3.090
1st 3.091
2nd 1.538
2nd 1.539
3rd 1.000
3rd 1.000
TOTAL GEAR RATIO
3.09
2.201
1.538
1.096
1
0.712

Fig. 1b

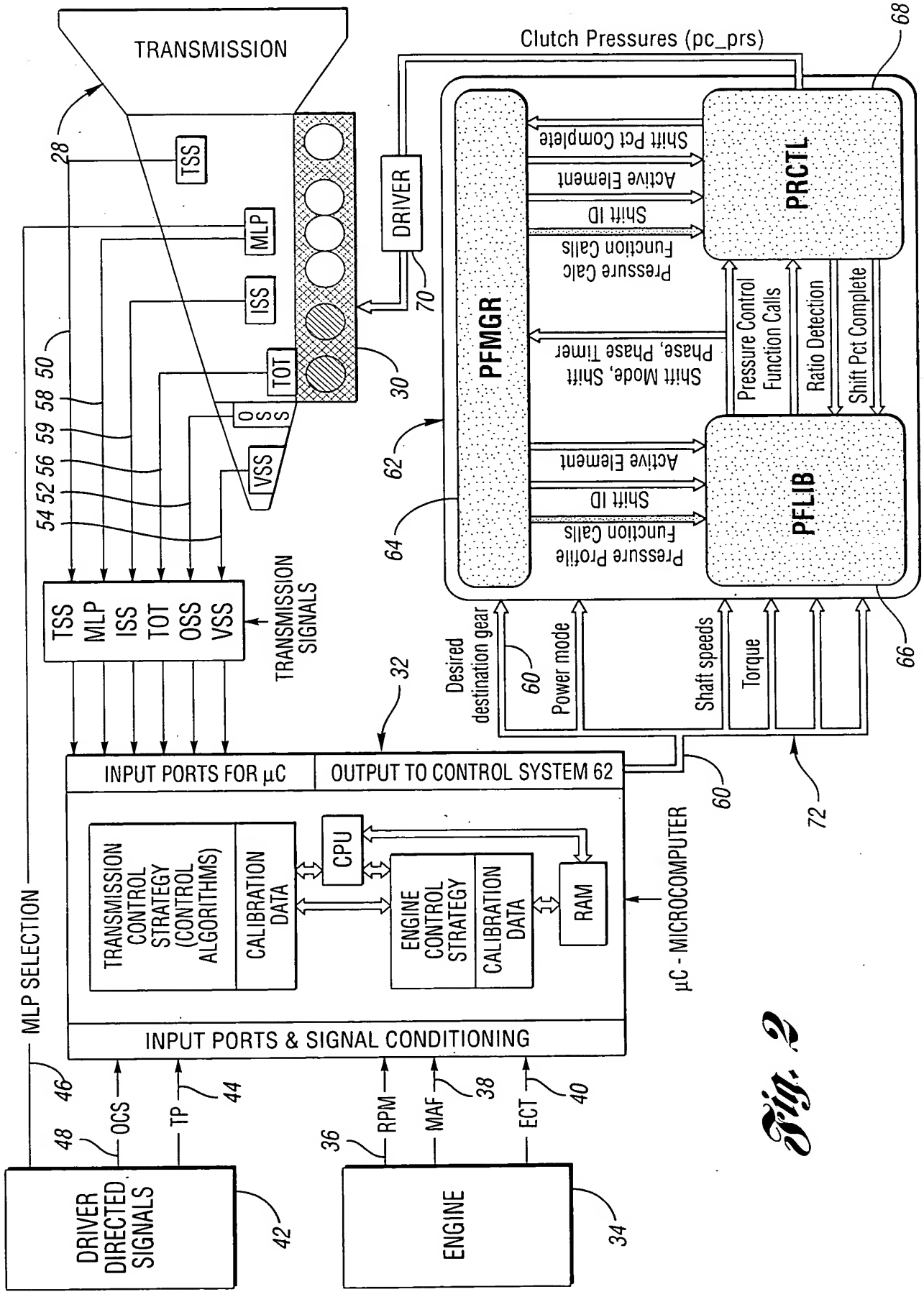
TRANSMISSION
28
TSS
MLP
ISS
TOT
OSS
VSS
DRIVER
70
30
Clutch Pressures (pc_prs)
68
PRCTL
Shift Pct Complete
Active Element
Shift ID
Pressure Calc Function Calls
PFMGR
Shift Mode, Shift Phase, Phase Timer
Pressure Control Function Calls
Ratio Detection
Shift Pct Complete
62
64
Active Element
Shift ID
Pressure Profile Function Calls
PFLIB
66
50
58
59
56
52
54
TRANSMISSION SIGNALS
32
Desired destination gear
60
Power mode
Shaft speeds
Torque
INPUT PORTS FOR µC
OUTPUT TO CONTROL SYSTEM 62
60
72
TRANSMISSION CONTROL STRATEGY (CONTROL ALGORITHMS)
CALIBRATION DATA
CPU
ENGINE CONTROL STRATEGY
CALIBRATION DATA
RAM
µC - MICROCOMPUTER
MLP SELECTION
INPUT PORTS & SIGNAL CONDITIONING
46
48
OCS
TP
44
RPM
MAF
38
ECT
40
36
DRIVER DIRECTED SIGNALS
42
ENGINE
34

Fig. 2

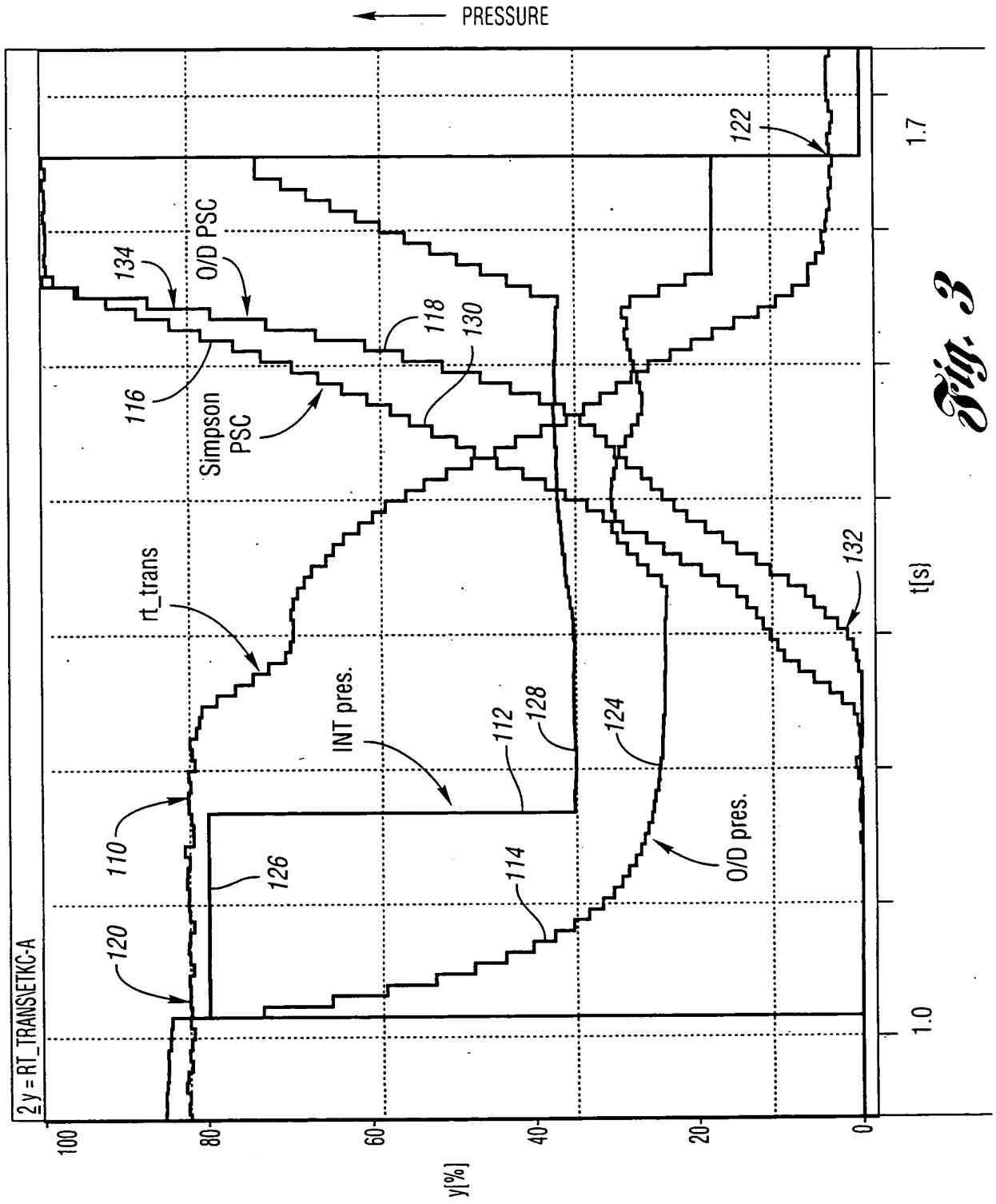
PRESSURE
2 y = RT_TRANSETKC-A
y[%]
100
80
60
40
20
0
t[s]
1.7
1.0
122
134
O/D PSC
118
130
116
Simpson PSC
rt_trans
INT pres.
112
128
124
132
O/D pres.
110
126
114
120

Fig. 3

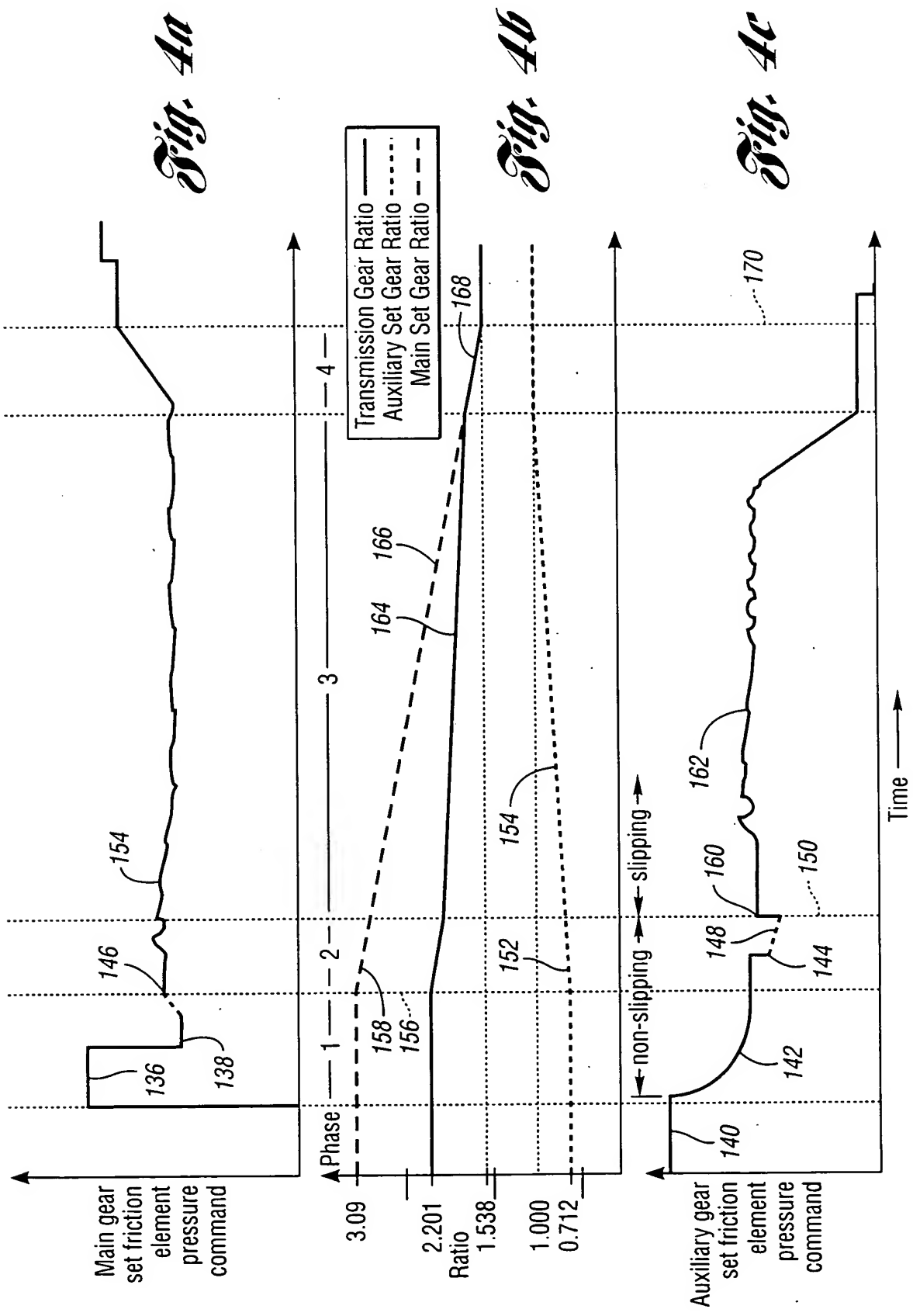
Fig. 4a
Fig. 4b
Fig. 4c
Main gear set friction element pressure command
Phase
Transmission Gear Ratio
Auxiliary Set Gear Ratio
Main Set Gear Ratio
3.09
2.201
1.538
1.000
0.712
Ratio
non-slipping
slipping
Auxiliary gear set friction element pressure command
Time
136
138
140
142
144
146
148
150
152
154
156
158
160
162
164
166
168
170

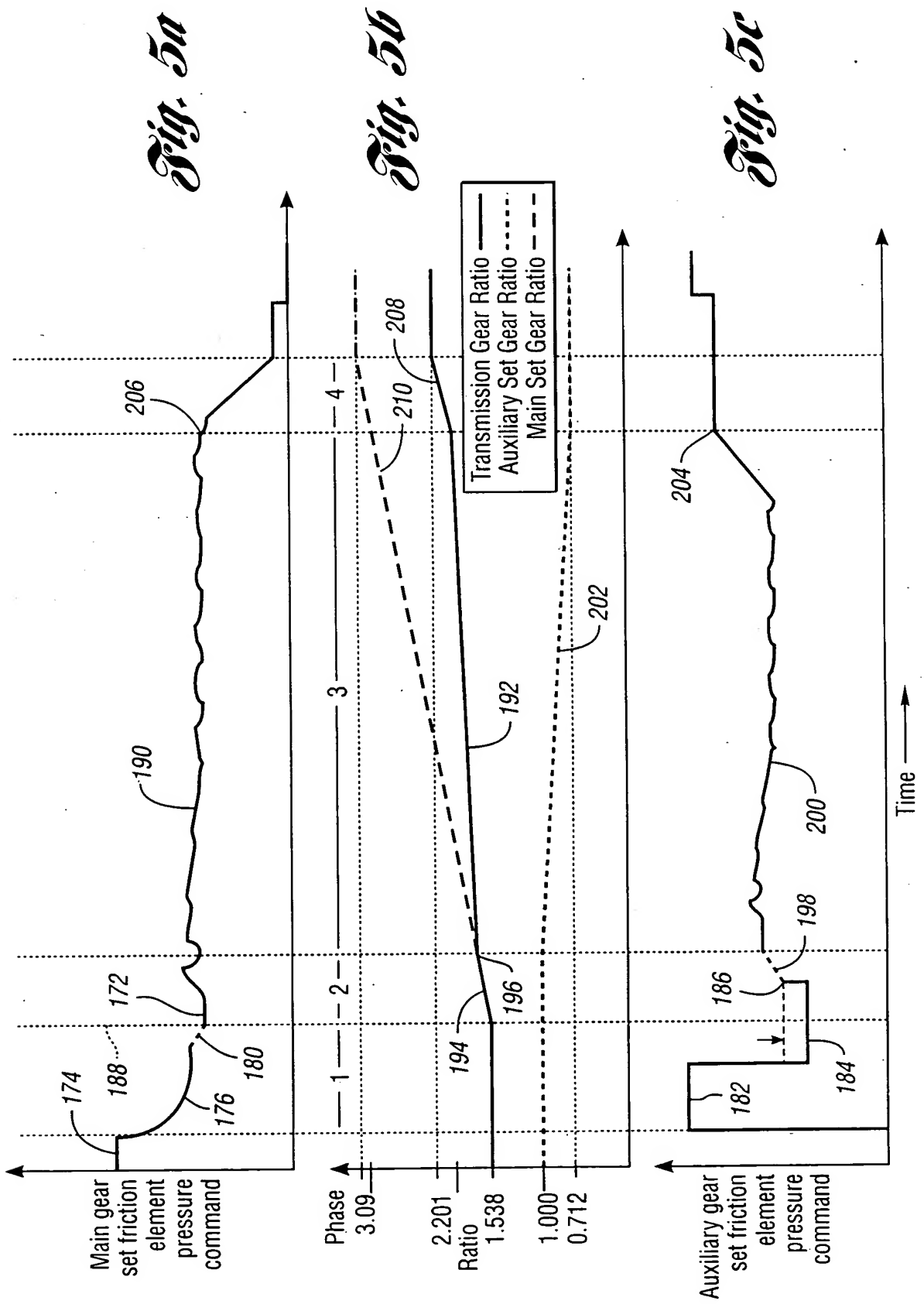
Fig. 5a
Fig. 5b
Fig. 5c
Main gear set friction element pressure command
Phase
3.09
2.201
Ratio
1.538
1.000
0.712
Transmission Gear Ratio
Auxiliary Set Gear Ratio
Main Set Gear Ratio
Auxiliary gear set friction element pressure command
Time
1
2
3
4
172
174
176
180
188
190
192
194
196
198
200
202
204
206
208
210
182
184
186

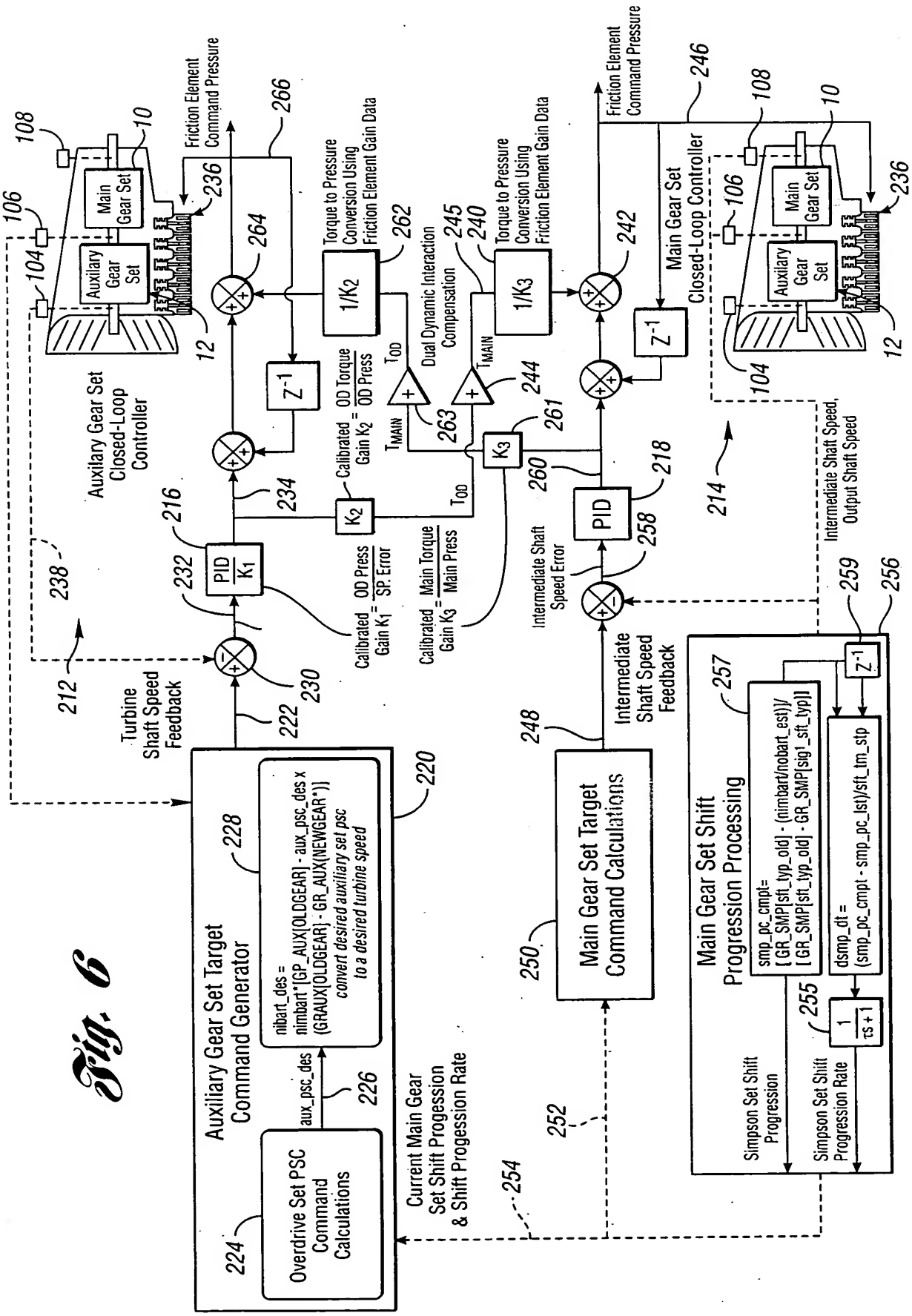
Auxiliary Gear Set Target Command Generator
Overdrive Set PSC Command Calculations
nibart_des = nimbart*[GP_AUX[OLDGEAR] - aux_psc_des x (GRAUX[OLDGEAR] - GR_AUX[NEWGEAR*])] convert desired auxiliary set psc to a desired turbine speed
aux_psc_des
Current Main Gear Set Shift Progession & Shift Progession Rate
Turbine Shaft Speed Feedback
Auxiliary Gear Set Closed-Loop Controller
Main Gear Set Target Command Calculations
Intermediate Shaft Speed Feedback
Main Gear Set Shift Progression Processing
smp_pc_cmpt= [GR_SMP[sft_typ_old] - (nimbart/nobart_est)]/ [GR_SMP[sft_typ_old] - GR_SMP[sig1_sft_typ]]
dsmp_dt = (smp_pc_cmpt - smp_pc_lst)/sft_tm_stp
Simpson Set Shift Progression
Simpson Set Shift Progression Rate
Main Gear Set Closed-Loop Controller
Intermediate Shaft Speed, Output Shaft Speed
Intermediate Shaft Speed Error
Calibrated Gain K1 = OD Press / SP. Error
Calibrated Gain K2 = OD Torque / OD Press
Calibrated Gain K3 = Main Torque / Main Press
Torque to Pressure Conversion Using Friction Element Gain Data
Dual Dynamic Interaction Compensation
Friction Element Command Pressure
Main Gear Set
Auxiliary Gear Set
PID
1/K2
1/K3
Z-1
212
214
216
218
220
222
224
226
228
230
232
234
236
238
240
242
244
245
246
248
250
252
254
255
256
257
258
259
260
261
262
263
264
266
10
12
104
106
108

Fig. 6

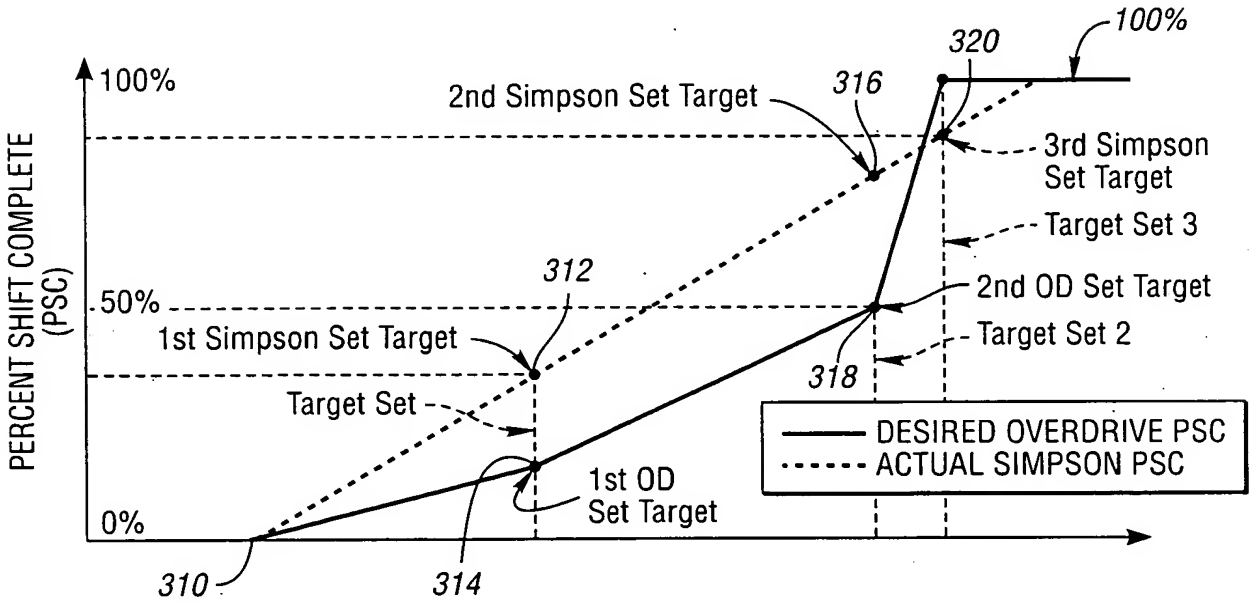
100%
PERCENT SHIFT COMPLETE (PSC)
50%
0%
2nd Simpson Set Target
316
320
100%
3rd Simpson Set Target
Target Set 3
312
2nd OD Set Target
1st Simpson Set Target
Target Set 2
318
Target Set
1st OD Set Target
DESIRED OVERDRIVE PSC
ACTUAL SIMPSON PSC
310
314

Fig. 7

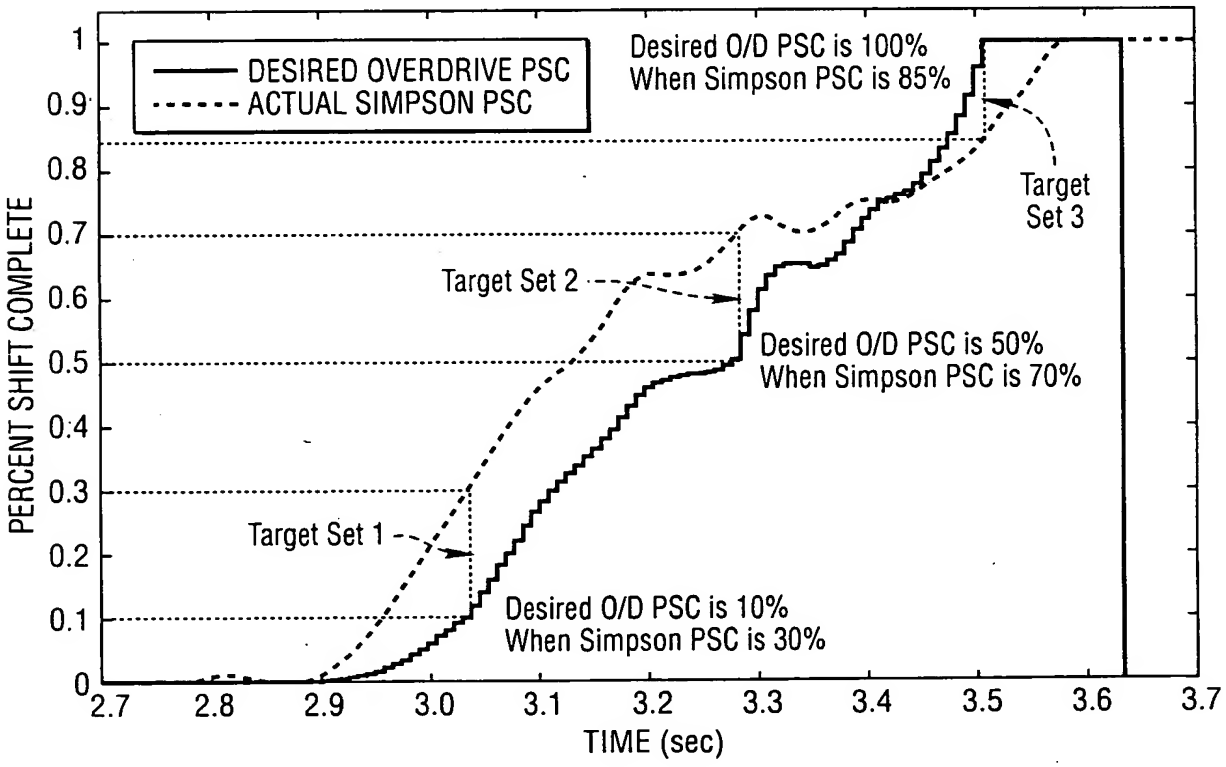
DESIRED OVERDRIVE PSC
ACTUAL SIMPSON PSC
Desired O/D PSC is 100% When Simpson PSC is 85%
Target Set 3
Target Set 2
Desired O/D PSC is 50% When Simpson PSC is 70%
Target Set 1
Desired O/D PSC is 10% When Simpson PSC is 30%
PERCENT SHIFT COMPLETE
TIME (sec)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4
3.5
3.6
3.7

Fig. 8

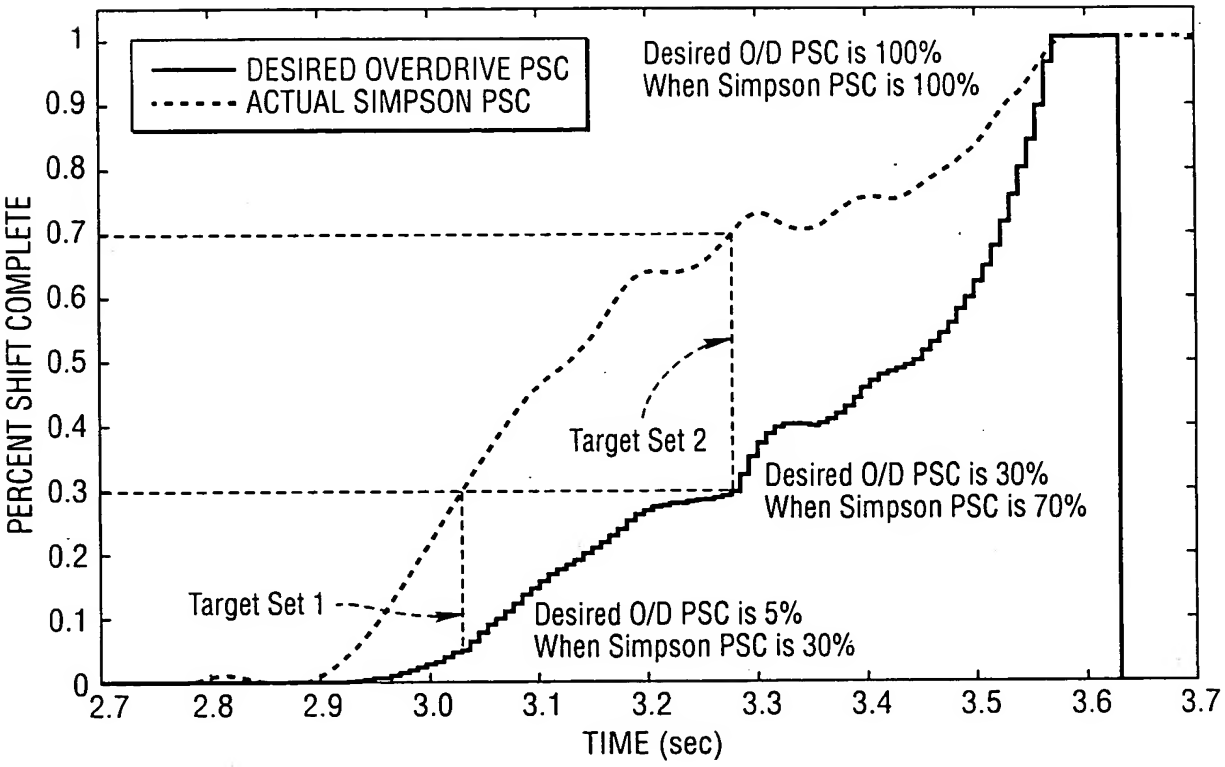
DESIRED OVERDRIVE PSC
ACTUAL SIMPSON PSC
Desired O/D PSC is 100%
When Simpson PSC is 100%
Target Set 2
Desired O/D PSC is 30%
When Simpson PSC is 70%
Target Set 1
Desired O/D PSC is 5%
When Simpson PSC is 30%
PERCENT SHIFT COMPLETE
TIME (sec)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
2.7
2.8
2.9
3.0
3.1
3.2
3.3
3.4
3.5
3.6
3.7

Fig. 9

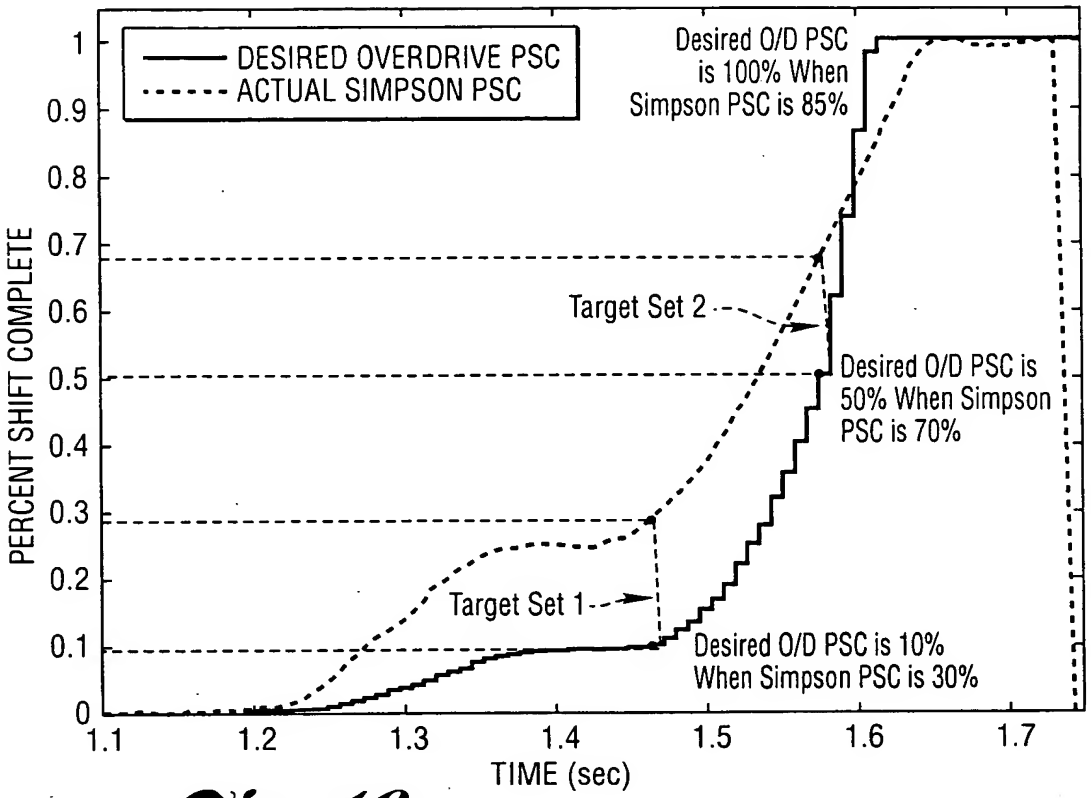
DESIRED OVERDRIVE PSC
ACTUAL SIMPSON PSC
Desired O/D PSC is 100% When Simpson PSC is 85%
Target Set 2
Desired O/D PSC is 50% When Simpson PSC is 70%
Target Set 1
Desired O/D PSC is 10% When Simpson PSC is 30%
PERCENT SHIFT COMPLETE
TIME (sec)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7

Fig. 10

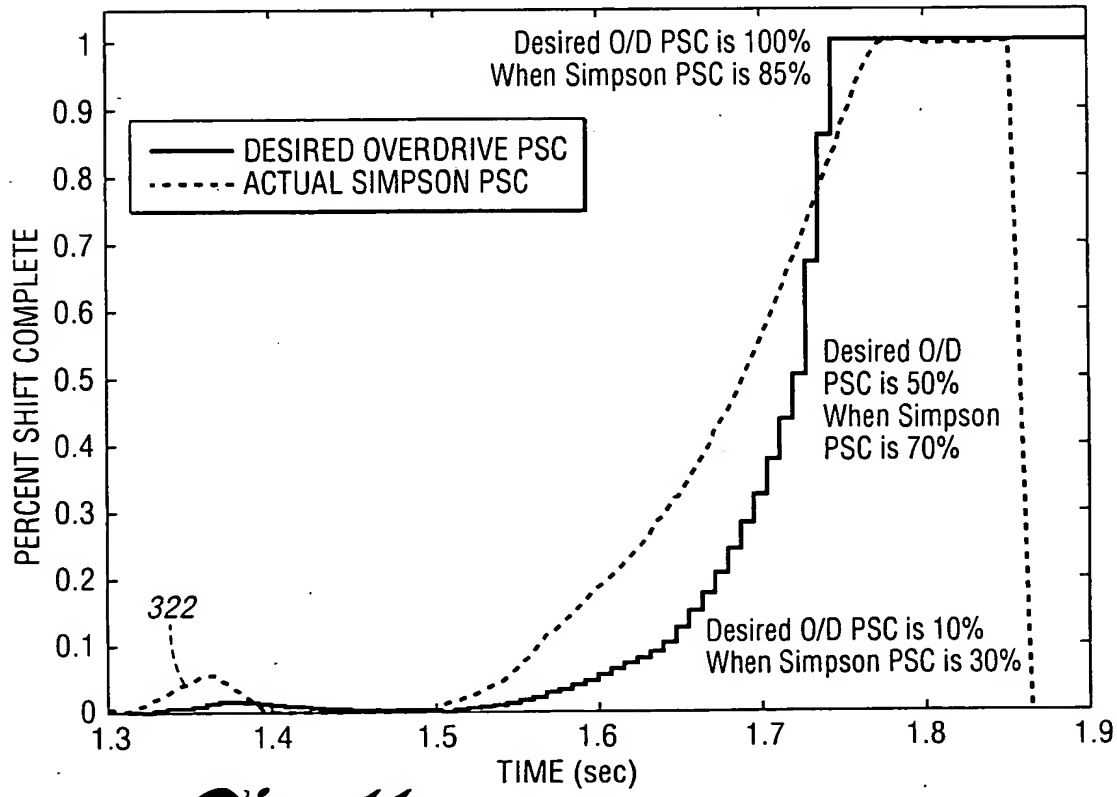
Desired O/D PSC is 100% When Simpson PSC is 85%
DESIRED OVERDRIVE PSC
ACTUAL SIMPSON PSC
Desired O/D PSC is 50% When Simpson PSC is 70%
322
Desired O/D PSC is 10% When Simpson PSC is 30%
PERCENT SHIFT COMPLETE
TIME (sec)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1.3
1.4
1.5
1.6
1.7
1.8
1.9

Fig. 11

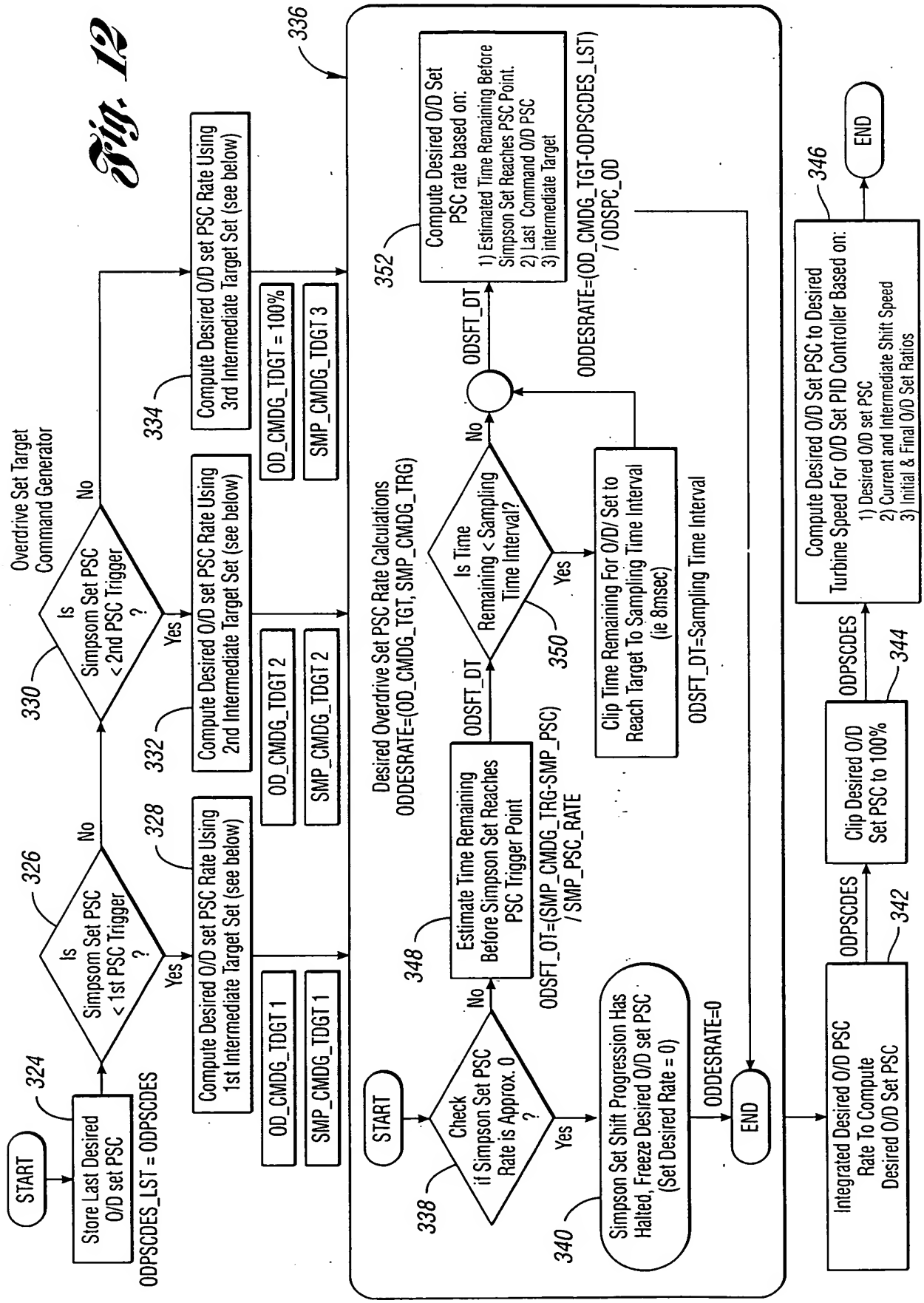
Fig. 12
START
Store Last Desired O/D set PSC
ODPSCDES_LST = ODPSCDES
324
Overdrive Set Target Command Generator
Is Simpsom Set PSC < 1st PSC Trigger ?
326
Yes
No
Compute Desired O/D set PSC Rate Using 1st Intermediate Target Set (see below)
328
OD_CMDG_TDGT 1
SMP_CMDG_TDGT 1
Is Simpsom Set PSC < 2nd PSC Trigger ?
330
Yes
No
Compute Desired O/D set PSC Rate Using 2nd Intermediate Target Set (see below)
332
OD_CMDG_TDGT 2
SMP_CMDG_TDGT 2
Compute Desired O/D set PSC Rate Using 3rd Intermediate Target Set (see below)
334
OD_CMDG_TDGT = 100%
SMP_CMDG_TDGT 3
336
Desired Overdrive Set PSC Rate Calculations
ODDESRATE=(OD_CMDG_TGT, SMP_CMDG_TRG)
START
Check if Simpson Set PSC Rate is Approx. 0 ?
338
Yes
No
Simpson Set Shift Progression Has Halted, Freeze Desired O/D set PSC (Set Desired Rate = 0)
340
ODDESRATE=0
Estimate Time Remaining Before Simpson Set Reaches PSC Trigger Point
348
ODSFT_OT=(SMP_CMDG_TRG-SMP_PSC) / SMP_PSC_RATE
ODSFT_DT
Is Time Remaining < Sampling Time Interval?
350
Yes
No
Clip Time Remaining For O/D/ Set to Reach Target To Sampling Time Interval (ie 8msec)
ODSFT_DT=Sampling Time Interval
ODSFT_DT
Compute Desired O/D Set PSC rate based on:
1) Estimated Time Remaining Before Simpson Set Reaches PSC Point.
2) Last Command O/D PSC
3) intermediate Target
352
ODDESRATE=(OD_CMDG_TGT-ODPSCDES_LST) / ODSPC_OD
END
Integrated Desired O/D PSC Rate To Compute Desired O/D Set PSC
ODPSCDES
342
Clip Desired O/D Set PSC to 100%
ODPSCDES
344
Compute Desired O/D Set PSC to Desired Turbine Speed For O/D Set PID Controller Based on:
1) Desired O/D set PSC
2) Current and Intermediate Shift Speed
3) Initial & Final O/D Set Ratios
346
END